

Development and Applications of 3D Cartesian CFD Technology

John E. Melton
NASA Ames Research Center
Moffett Field, CA

Marsha J. Berger
Courant Institute
New York, NY

The urgent need for dramatic reductions in aircraft design cycle time is focusing scrutiny upon all aspects of CFD. These reductions will most likely come not from increased reliance upon user-interactive (and therefore time-expensive) methods, but instead from methods that can be fully automated and incorporated into "black box" solutions. In comparison with tetrahedral methods, three-dimensional Cartesian grid approaches are in relative infancy, but initial experiences with automated Cartesian techniques are quite promising. Our research is targeted at furthering the development of Cartesian methods so that they can become key elements of a completely automatic grid generation/flow solution procedure applicable to the Euler analysis of complex aircraft geometries.

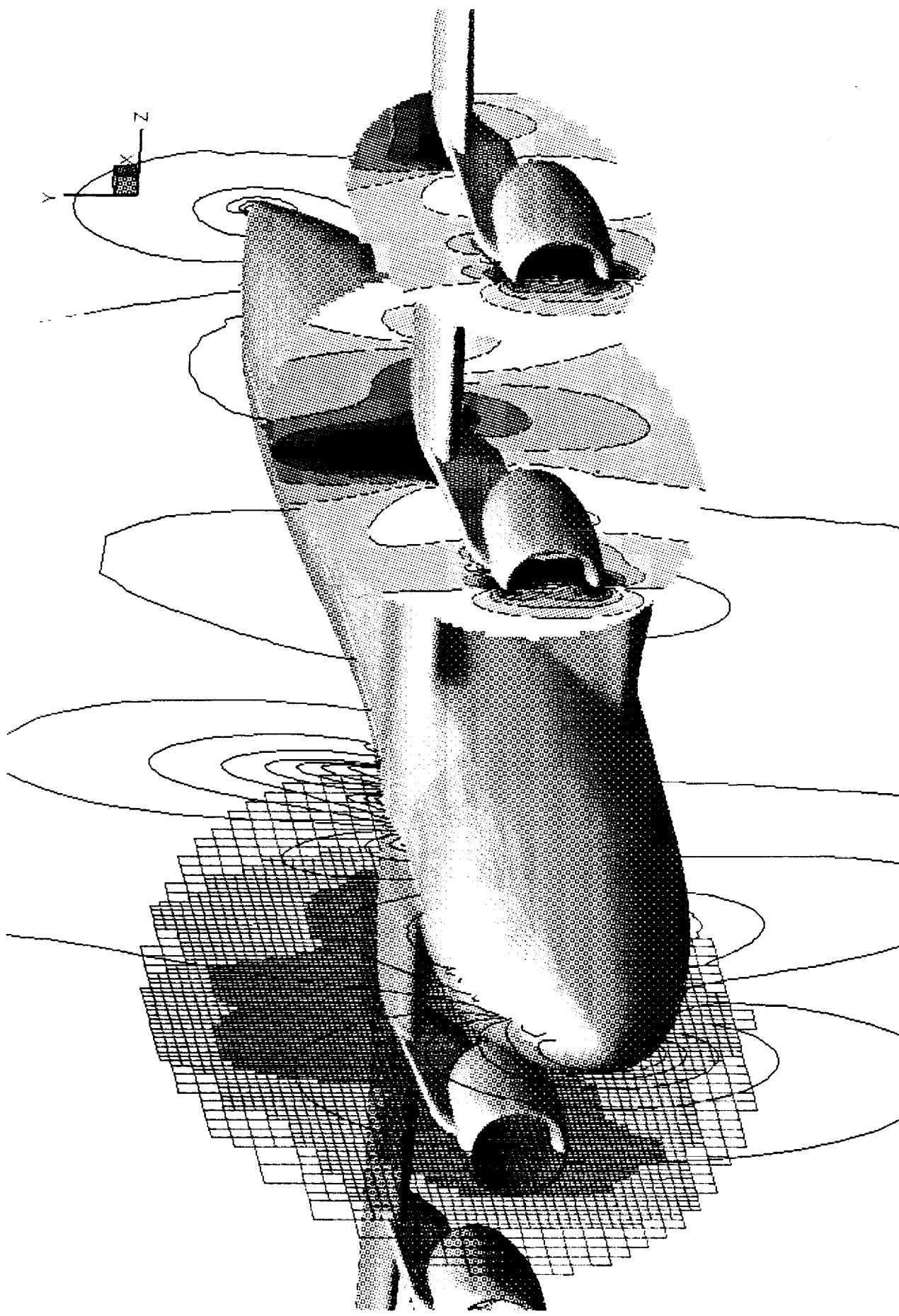
Cartesian approaches are of course beset with their own unique and interesting difficulties. Removal of the body-fitted grid constraint allows the Cartesian hexahedra used to discretize the flow field to intersect the surface in an arbitrary manner. Successful research into the development of robust procedures for the efficient creation and distribution of the hexahedra has produced an automatic, "hands-off" procedure for Cartesian grid generation. Additional efficiency gains have resulted from the adoption of a component-based approach to surface modeling. This approach streamlines the labor-intensive CAD/CAM process of creating the input surface discretizations and eliminates the need to regenerate new surface grids containing updated intersection information when individual components are translated or rotated. New intersections between components are automatically recognized and captured by the grid generation procedures, significantly improving the usefulness of the code in a design effort. This capability greatly expedites the analysis of complicated three-dimensional multi-body geometries, such as multi-component high lift systems or configurations involving arbitrary control surface deflections. Current research is focusing upon the modeling of extremely thin components. The organization and implementation of the grid generation

algorithms will be described in the proceedings paper. The accurate implementation of the surface boundary conditions is crucial to the success of any flow field simulation procedure. Research into this challenging area has produced improved boundary conditions routines with increased accuracy. The effects of these routines will also be presented in the proceedings paper.

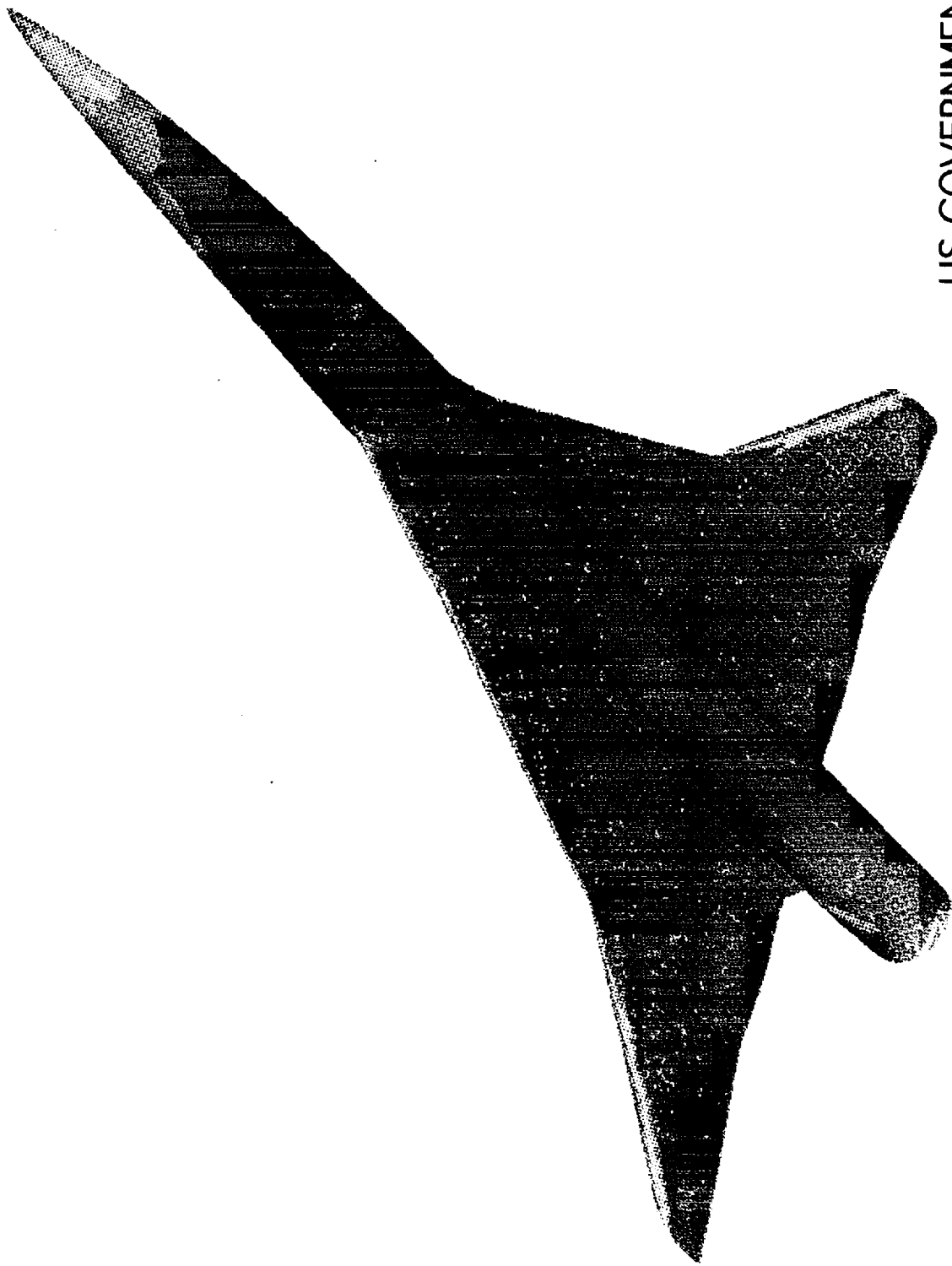
Demonstrations of some successful three-dimensional applications of the resultant Cartesian CFD technology are illustrated in figures 1 and 2. All of the applications were performed on the CRAY C-90 at the Numerical Aerodynamics Simulation facility at Ames. In figure 1a, a portion of the Cartesian grid for an advanced transonic transport is displayed along with some selected planes of the flow field painted by the pressure distribution. A curvature-sensitive grid refinement algorithm was used to initially refine the flow field grid about the nacelles and pylons, at the fuselage nose, and around the leading and trailing edges of the wing. Additional automatic refinements were performed to increase the resolution of shocks and large gradient regions in the flow field. Figure 1b shows the surface pressure distribution for a supersonic civil transport aircraft. In figure 2, selected comparisons of the supersonic lift, drag, and pitching moment characteristics for the supersonic transport are compared with wind tunnel data. Additional information about these computations will be detailed in the proceedings paper.

Correspondence should be sent to:

John Melton
M/S 227-6
NASA Ames Research Center
Moffett Field, CA 94035
(415) 604 - 1461
FAX: (415) 604 - 4357



US GOVERNMENT USE ONLY



US GOVERNMENT USE ONLY

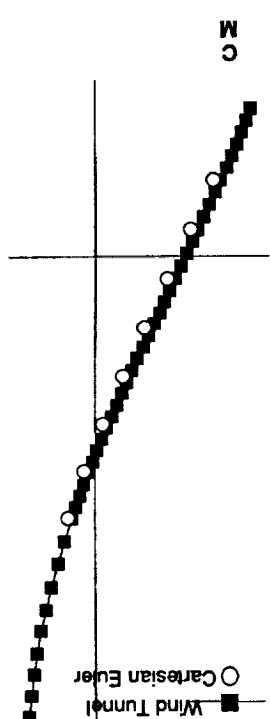
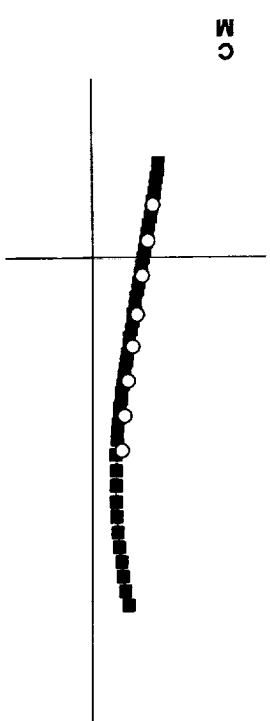
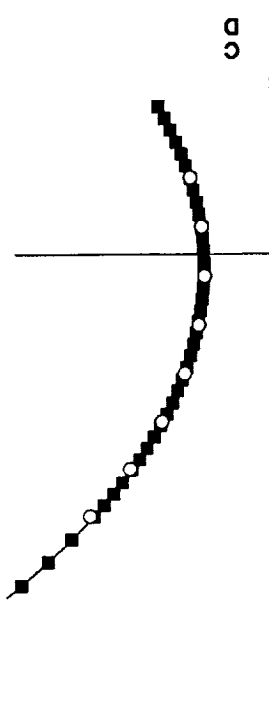
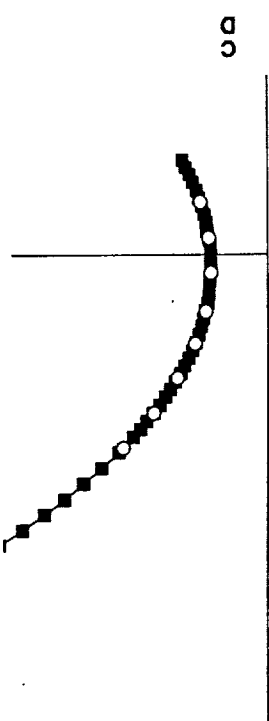
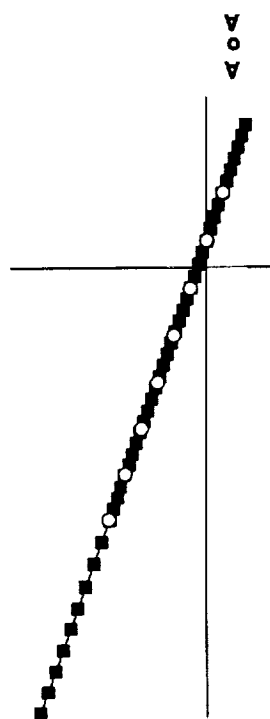
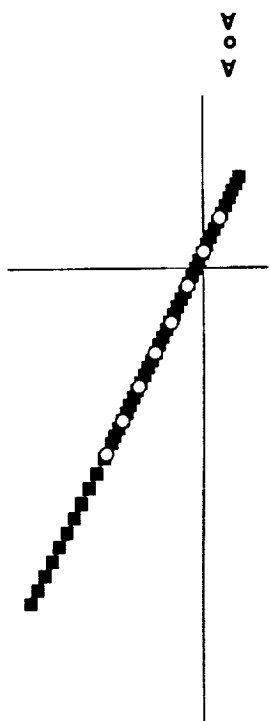


Figure 2

■ Wind Tunnel
 ○ Cartesian Euler